Would You Bolt A Swamp Cooler To Your DX Rooftop Unit?
[not exactly....]

New Buildings Institute
SWEEP-WCEC
July 23, 2013
Evaporative Family Tree

Evaporative Cooling Technologies

- Single Stage Evaporative (100% outside air)
  - Direct evaporative
  - Indirect evaporative
    - Traditional indirect
    - Maisotsenko cycle

- Hybrid Systems (100% outside air)
  - Indirect / Direct evaporative
  - Indirect / DX compressor
    - Multi-stage built-up systems

- Evaporative DX Refrigeration Cycle Enhancements (conventional outside air)
  - Evaporative condenser
  - Cycle control strategies
    - Evaporative enhancements to de-superheating, sub-cooling

Traditional indirect
Maisotsenko cycle
NEEA – NBI Evaporative RTU Projects

- 2007: *CoolAire*, Proof-of-concept, 5-ton Desert Aire Indirect/DX hybrid, multiple sites NW/CA; marketed as the Coolerado H80
- 2010: Speakman 5-ton Indirect Direct (IDEC)/DX hybrid; 2 Idaho sites
- 2012: AirMax, 5-ton IDEC add-on; 1 Idaho site
- 2013: 4\textsuperscript{th} generation AIR\textsubscript{2}O + Coolerado M50 add ons; 1 Idaho, 1 Vancouver, WA
Desert CoolAire, Portland, OR
Desert CoolAire™ Package Rooftop Unit

- Refrigerant Capacity (DX): 48,000 btu [1.5t works]
- Total Cooling Capacity: 60,000 btu
- Total Heating Capacity: 115,000 btu
- Compressor: 10-100% Digital modulating scroll
- VFD Blower
- Supply Air: 1800 CFM at 1 inch ESP
- 132”L x 54”W x 60”H
- 2300 lbs wetted
CoolAire Unit Layout

- Electrical Box
- Purge Damper
- Blower Assembly
- Indirect Evaporative Cooling Modules
- R-22 Condenser
- Liquid Receiver
- Condenser Discharge Air
- 2 Stage Gas Heater
- Evap Coil
- Modulating Compressor
- Discharge Air Duct Opening
- Fresh Air Intake Dampers
- Return Air Dampers
Maisotsenko Cycle

**How it works:**

1. Product air and working air enter the dry side of the HMX.
2. Cooled working air is fractioned off into wet channels throughout the exchanger.
3. Heat from the product air is transferred into the working air through evaporation and is rejected as exhaust.
4. The product air travels the length of the dry channels, while transferring its heat to the working air in the wet channels above and below. As a result, the product air cools down and remains dry as it enters the building.
Delphi Indirect HMX Core
CoolAire CA Sacramento 100°F

The Dx provides 17°F cooling for supply air at 50°F. The Dx role would be very small (5-10°F) at more typical supply air points of 55-60°F.

32°F cooling from the HMX core!
Boise Idaho

CoolAire Site #15

08/21/06 - 08/21/06

30 degrees cooling from the core!
CoolAire – Boise 100°F

Hourly Demand Comparison
- hi cooling case

Time of day

Hourly Demand (KW)

As operated
SEER 13
CoolAire Results – Boise 85-87°F
CoolAire Findings

- Modest Energy Savings: 23%
- Strong Demand Savings: 2-3 kW (33-49%)
- Non-optimal prototype design & control (excessive fan energy, overuse of Dx, too much H2O)
- 25 EER evap peak/15 EER system @ 103°F
- Possible 20%+ improvement with redesign
Coolerado H80 - Western Cooling Challenge

Coolerado H80, 5-ton RTU, NREL tested

- WCC sensible EER spec @ 90°F ≥17 MEASURED = 51.8 EER
- WCC sensible EER spec @ 105°F ≥14 MEASURED = 21.7 EER

MEASURED REDUCTIONS = 80% kWh/58% kW
AIR™ QUATTRO™ HYBRID

5 TO

pressure

CANCELLED

nbi new buildings institute
AirMax Indirect Direct Arriving
AirMax IDEC
Equipment Overview

- 3 gen unit (2\textsuperscript{nd} gen IDEC/DX hybrid)
- Add-on to existing 5 ton RTU
- IDEC/RTU interface fabricated in the field
AirMax IDEC Overview

Direct evaporative media Munters CELdek® 5090
Indirect evaporative matrix Munters CELdek® 7090
ACSESS™ Controller
(TruPsych obsolete)

Four modes of operation:
1. Economizer
2. Direct
3. IDEC
4. DX mode

Source: TruPsych Technical Guide 2.0
Idaho IDEC Project Ductwork
IDEC Performance

EER vs Temperature

Outide Air Temperature, deg F

-10 -0 10 20 30 40 50

EER

Indirect/direct
Direct
Direct model
Indirect/direct model
Savings Potential

Compressor/Evaporative Mode Comparison

- Aug 1-14 (Compressor Mode)
- Aug 15-30 (Evap. Mode)
Water Usage

- Direct mode water-use efficiency = 95%
- IDEC mode water – use efficiency = 30%
Water Usage Signature

Flow Signature

Water Flow, Gal/day

Average 24 hour Temperature, deg F

Flow (gal)
Model
Water Usage

Water use associated with RTU only energy use = 28,600 gallons
Water use associated with RTU/IDEC energy use PLUS direct water use by IDEC = 20,000 gallons
Summary

<table>
<thead>
<tr>
<th>Equipment</th>
<th>RTU</th>
<th>IDEC</th>
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<tbody>
<tr>
<td>Electric Energy (kWh)</td>
<td>6,475</td>
<td>2,849</td>
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<td>Electric Demand (kW)</td>
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- Savings projections: energy @ 56% (3,600 kWh/yr) – additional savings achievable with refinement of control settings
- Demand @ 65% (3.6 kW)
- Revisions recommended
IDEF 4th Gen Unit

- Blower change: from external rotor motor 960 W single-speed (2500@ 0.5 inch) to 1.1 kW blower internal rotor 3-speed (3000 CFM @ 0.5 inch or 2500 CFM @ 1 inch)
- Control board changes:
  - Added LCD to replace dipswitches
  - Runs the economizer or direct or direct/indirect as a 3-stages unit which saves water usage
  - Increased purge system control accuracy
  - ACSESS™ control board fully integrated into the cabinet
  - Water coil and water pump redesigned completely to allow 100% winter drain down
  - Standard’ beige cabinet color
GreenAire AIR$_2$O

AIR$_2$O ADVANTAGE: THE MOST INNOVATIVE AIR CONDITIONING SOLUTION.

100% FRESH AIR. UP TO 80% ENERGY SAVING.

CATALOG 2013
# AIR₂O IDEC US Savings Estimates

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<thead>
<tr>
<th>City</th>
<th>Rank</th>
<th>Total Evap. IDEC + Direct Hrs/Yr</th>
<th>Evaporative Direct Hrs/Yr</th>
<th>Evaporative Indirect/Direct Hrs/Yr</th>
<th>DX AC Hrs/Yr</th>
<th>Total Non-Economizer Cooling Hours</th>
<th>% Without DX AC</th>
<th>IDEC Add-on kWh Savings</th>
<th>kW Peak Demand Yearly Savings</th>
<th>Water Consumption Avarge G/Ton/Hr</th>
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</table>
Evaporative Cooling Challenges

• Old direct evaporative technology image
• Managing mineral scale
• Putting water usage in context
• Potential changes to ventilation design for higher airflow rates
• Lack of recognition in codes and HVAC efficiency ratings
• Lack of knowledge on the part of owners, contractors, designers, facility managers
• Advanced evap. vendors are small companies
• Limited regulatory, policy & utility involvement
Thanks To All


• http://newbuildings.org/sites/default/files/NEEA-DesertCoolAireTechnicalAssessment2007Addendum_0.pdf

• http://newbuildings.org/sites/default/files/NBI_NEEA_40363_EvapHVACreport.pdf

Mark Cherniack
markc@newbuildings.org